Label Free Virus Detection in Complex Biological Environments Using Enhanced Darkfield Hyperspectral Microscopy

CytoViva Illuminating the Future

CytoViva's Enhanced Darkfield Hyperspectral Microscopy has been demonstrated to provide label free detection of virus particles in complex biological environments. Most notable was a publication demonstrating hyperspectral mapping of the H1N1 virus in epithelial lung cells.[1]

The CytoViva system incorporates patented enhanced darkfield microscope optics, which are proven to create up to a 10x improvement in signal-to-noise scatter detection of nanoscale sample elements versus standard optics.[2] When combined with CytoViva's proprietary hyperspectral imaging technology, the integrated system can provide rapid mapping of certain virus particles based on their unique optical spectrum. This is possible as hyperspectral imaging captures the VNIR optical spectrum (400nm-1,000nm) in every image pixel. Spectral resolution is approximately 2nm across this VNIR spectrum in each nanoscale image pixel. A complete hyperspectral image can be captured in minutes.

This capability to detect nanoscale viral particles has significant utility not only for infectious disease research, but also the fast growing area of viral cancer immunotherapy and other virology based research.

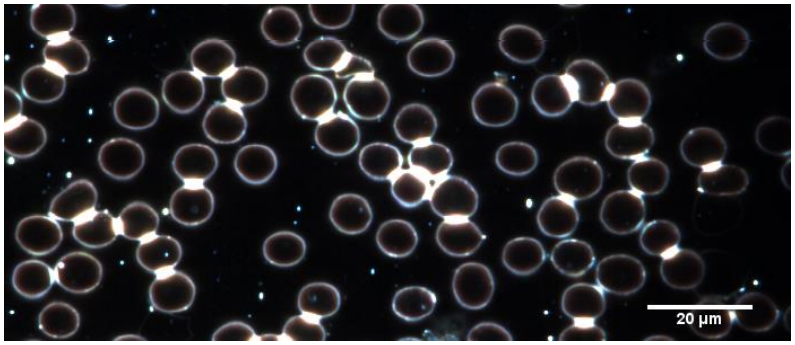

Figure 1: Whole blood sample from subject experiencing viral infection symptoms. Note, bluish viral particles present throughout the image.

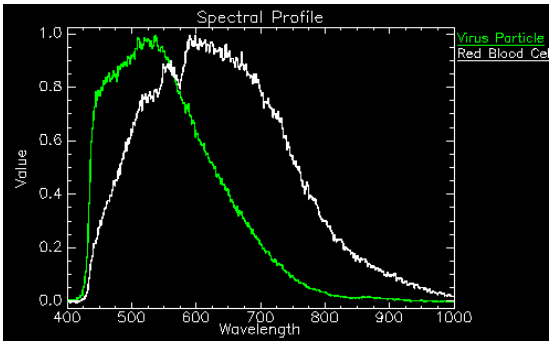

Figure 2: Comparative spectrum of virus particles (**green**) and red blood cell membrane (**white**).

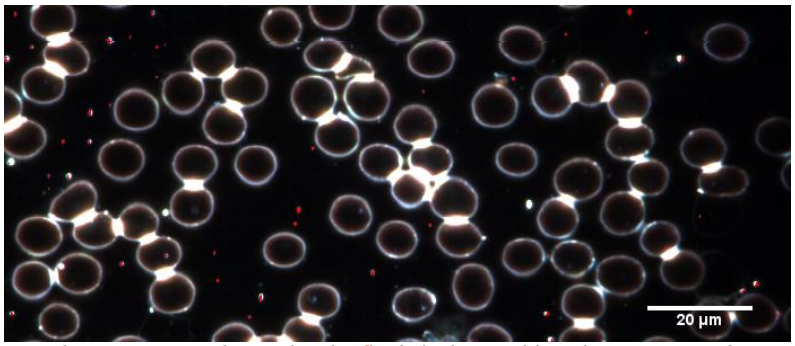

Figure 3: Spectral Mapping (**red**) of pixels matching virus spectrum from the image in figure 1 above.

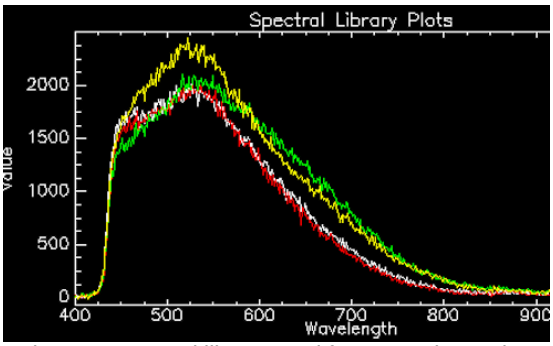

Figure 4: Spectral library used for spectral mapping in figure 3.

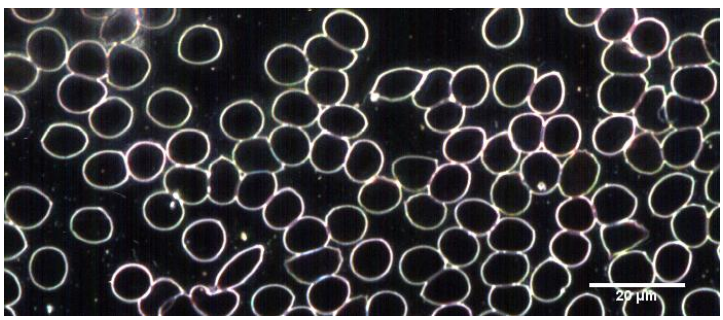

Figure 5: Whole Blood sample from subject taken 30 days after viral infection. No spectral mapping occurs when using virus spectral library from figure 4.

CytoViva, Inc. | 570 Devall Drive, Suite 301 | Auburn, AL 36832 | info@cytoviva.com | 1-888-737-3130
www.cytoviva.com

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To demonstrate this capability, a whole blood sample was recently imaged from a subject experiencing symptoms from a viral infection. The hyperspectral image from this blood sample is shown in figure 1 above. Note the “bluish scatter” from these viral nano particulates mostly in the plasma area of the sample. The spectral profile of these particles has characteristics similar to pure virus samples such as RSV. This spectrum is illustrated in figure 2 and compared to the optical spectrum of the membrane of a red blood cell. Figure 3 illustrates spectral mapping (in red) of these virus particles in the whole blood sample. This mapping utilized the virus spectral library shown in figure 4.

Approximately one month later, a new whole blood sample was collected from this subject, who was no longer exhibiting symptoms of a viral infection. This sample is shown in figure 5. Using the identical spectral library (in figure 4) of the virus particles, the spectral mapping exercise was again conducted on the new whole blood sample from the same subject. This time, no spectral mapping occurred indicating the absence of the virus in the whole blood from the subject no longer experiencing viral infection symptoms.

This example data provides insight regarding the ability of CytoViva’s Enhanced Darkfield Hyperspectral Microscope to rapidly detect and spectrally map virus particles in a complex biological environment. To better understand how the system can impact your research on viruses or other types of nanoscale samples, please contact us at info@cytoviva.com. We will be pleased to discuss your research and conduct test imaging of your samples as appropriate.

[1] Sanpui, P., Zheng, X., Loeb, J.C. et al. Single-walled carbon nanotubes increase pandemic influenza A H1N1 virus infectivity of lung epithelial cells. Part Fibre Toxicol 11, 66 (2014). https://doi.org/10.1186/s12989-014-0066-0

[2] Zhang, P., Park, S. and Kang, S.H. (2015), Microchip Electrophoresis with Enhanced Dark-Field Illumination Detection for Fast Separation of Native Single Super-Paramagnetic Nanoparticles. Bull. Korean Chem. Soc., 36: 1172-1177. doi:10.1002/bkcs.10219